

## Special Report

# Fitch CDS Implied Ratings (CDS-IR) Model

## Analysts

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## Summary

The Fitch CDS Implied Ratings (CDS-IR) model processes the collective marketplace view of firms' credit condition based on its current CDS pricing and region. It then calculates and converts these into implied ratings.

The Fitch CDS-IR model is a proprietary and data-intensive rating model that covers a global universe and refines market information into a model-based credit assessment. The principal output is a forward-looking credit assessment expressed in the traditional rating grade. The model's comprehensive scope, data-intensive foundation, and exhaustive validation testing ensure robust out-of-sample predictive power. CDS-IR rating outputs are useful with regard to absolute levels and relative changes across time.

Model calibration for the Fitch CDS-IR is based principally on The Fitch CDS Pricing Service data which goes back from present time to 1999 globally on a daily basis.

The Fitch CDS-IR model covers over 2,500 reference entities in 84 countries globally. All industries are covered by this model, including Financials and Sovereigns. The model provides daily output of market implied credit ratings.

Testing and validation of Fitch CDS-IR includes: 1) in-sample Hit-Miss Matrices by region, 2) out-of-sample Forward Analysis to examine how well implied ratings forecast changes predict agency ratings, and 3) the Accuracy Ratio from Cumulative Accuracy Profile plots to gauge the ratings' ability to rank order obligors.

The Fitch CDS-IR model is an accurate market implied rating tool that has undergone out-of-sample validation across its coverage universe globally.

## Introduction

The Fitch CDS-IR model is an empirical, data intensive model that is based on Credit Default Swap (CDS) prices. The CDS market is the purest and most responsive indicator of corporate credit risk available. Since its inception early in the 1990s, the CDS market has evolved into a major component of the capital markets.

Stated simply, a CDS is similar to an everyday insurance contract with the exception that CDS contracts are freely tradable while insurance contracts are not. In other words, a CDS is a privately negotiated bilateral contract between two parties: A & B. Party A, usually known as the protection buyer (or 'risk shedder' in the parlance of the BIS<sup>1</sup>), pays a fee or premium to party B, generally referred to as the protection seller (described by the BIS as the 'risk taker'), to protect himself against potential loss (termed a "credit event") for a defined term. The CDS contract will explicitly define this "credit event," indicating that some obligor (known as "reference entity C" on which the CDS "has been written" is unable (or is rapidly soon to become unable) to pay its debts. If a credit event occurs, the seller of protection will make a payment to the buyer of the contract.

**CDS Advantages - Pure, Light, & Liquid:** CDS prices are a fairly *pure* indicator of credit risk because the structure separates the credit risk component from the other asset risks, such as interest rate and currency risk. In addition, they are "*light*" instruments in that one does not need to fund an entire bond position, for example, to have essentially the identical credit risk exposure. Finally, CDS pricing has become *liquid* with standardized ISDA<sup>2</sup> contracts and exponentially growing markets. Total market size of CDS (notional outstanding) was \$17 trillion by broker estimates in April 2006.<sup>3</sup>

## For options for CDS Restructuring

In addition to basic CDS contract terms such as referenced entity, maturity, notional amount, and rate/price, CDS contracts come in four different flavors according to the restructuring mechanism. Restructuring has been the most problematic "credit event." The main issue is that, unlike bankruptcy or failure-to-pay, some debt restructuring may not lead to investor losses. Moreover, even if investors suffer financial losses, the amount of loss is more difficult to determine, if restructuring of debt involves an exchange of bonds with different coupons and/or maturities. Accordingly, the current ISDA agreement offers four options for treating the issue of restructuring as follows:

1. **No Restructuring (NR):** This option excludes restructuring altogether from the contract, eliminating the possibility that the protection seller suffers a "soft" credit event that does not necessarily result in losses to the protection buyer. Note that some of the most popular CDS indices in North America (for instance, the

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<sup>1</sup> The Bank for International Settlements (BIS) is an international organization of central banks based in Basel, Switzerland, which exists to "foster cooperation among central banks and other agencies in pursuit of monetary and financial stability." Most pertinent here are its capital regulations known as the Basel Accord (or Basel II) that defines required capital levels for banks.

<sup>2</sup> The International Swaps and Derivatives Association (ISDA) is a New York based trade organization of brokers and dealers for over-the-counter derivatives, which creates standardized derivatives contracts to facilitate market liquidity.

<sup>3</sup> "On Top of the World", Economist, 27-April-2006, [http://www.economist.com/opinion/displaystory.cfm?story\\_id=6855910](http://www.economist.com/opinion/displaystory.cfm?story_id=6855910)

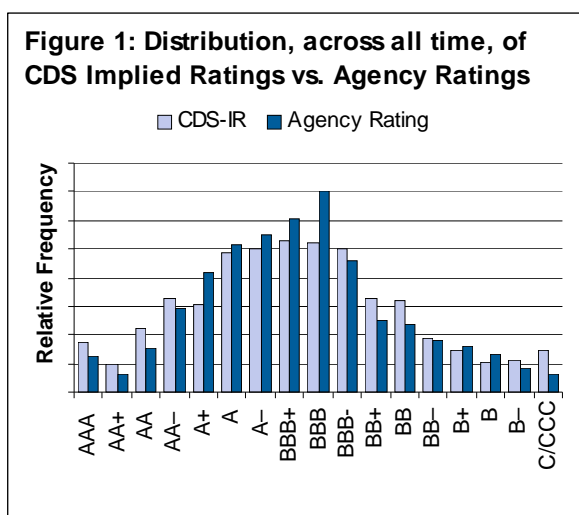
DJ.CDX.NA.IG and DJ.CDX.NA.HY indices) trade under the no-restructuring definition.

2. **Full Restructuring:** The full-restructuring clause was the standard contract term in the 1999 ISDA credit derivatives definitions. This allows the protection buyer to deliver bonds of any maturity after restructuring of debt in any form occurs.
3. **Modified Restructuring:** In 2001, to limit the scope of opportunistic behavior by sellers in the event of restructuring agreements that did not cause loss, ISDA published a modified restructuring clause. Modified restructuring has become common practice in North America in last few years, which limits deliverable obligations to bonds with maturity of less than 30 months after a restructuring.
4. **Modified Modified Restructuring:** In 2003, a further modification of the modified restructuring clause was introduced, in response to the market perception (particularly in Europe) that the modified restructuring had been too severe in its limitation of deliverable obligations. This is a “modified” version of the modified restructuring option, which resulted from the criticism of the modified restructuring that it was too strict with respect to deliverable obligations. Under the modified-modified restructuring, which is more popular in Europe, deliverable obligations can be maturing in up to 60 months after a restructuring.

According to market practice, the different flavors of restructuring terms are more or less prevalent according to region. As detailed below, Fitch CDS-IR utilizes each region’s preferred terms to best utilize available market data.

### Coverage and Data

**Fitch CDS Pricing Source:** The Fitch CDS Pricing Service is a leading provider of CDS data with CDS curves received daily from all major market players. Available from 6 month to 30 year maturities, there are over 2,500 daily reference entities that are scrubbed and aggregated.

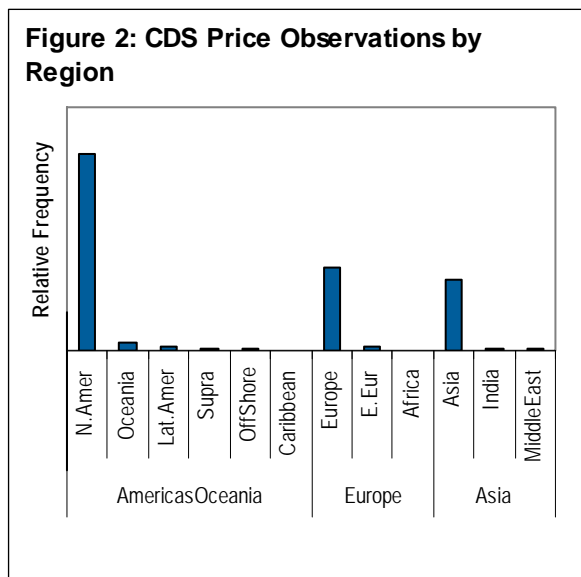


### Historical Distribution of Ratings

Another strength of using Fitch CDS data is that the distribution of agency ratings represented in CDS data is quite comparable to the distribution of agency ratings in the general bond population. Thus, there is reasonable confidence that the CDS market serves as a representative base on which to build a ratings model.

### CDS Observations by Region

The Fitch CDS-IR captures CDS price observations globally and organizes them into 12 regions. Three of the 12 regions dominate the dataset: North America, Europe, and Asia. As discussed below, the remaining nine regions are grouped with one of these three based on defining market characteristics.



According to market practice, the prevalence of the four types of restructuring clauses varies by region (see Figure 3). Since the credit event definition that triggers a CDS is different between the restructuring clauses, the CDS spreads (in bps) are not directly comparable among these groups. Thus, Fitch CDS-IR divides the CDS universe into three sub-models based on region. Each of these three regions utilizes the most prevalent restructuring form for that region:

**Table 1: Prevailing Restructuring Form by Region**

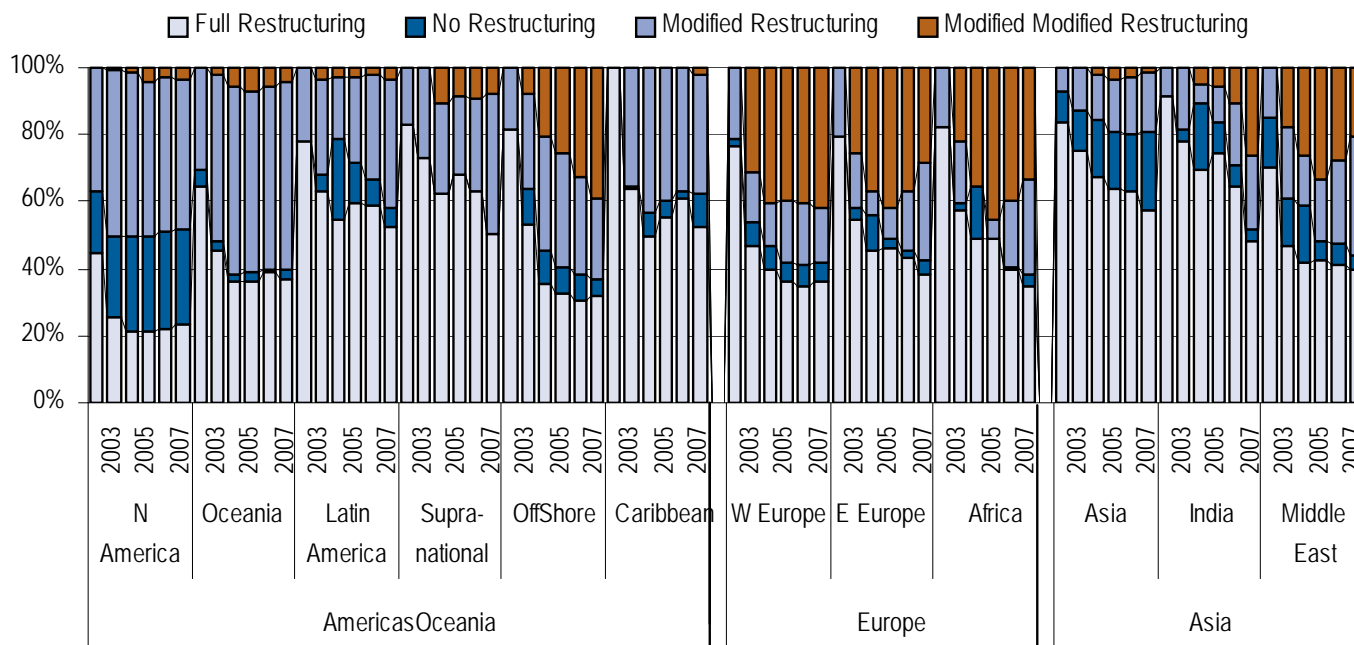
Region	Restructuring Form
Americas & Oceania	Modified
Europe & Africa	Modified Modified
Asia	Full

**Data Cleaning:** The Fitch CDS Pricing Service subjects the CDS spreads to a rigorous cleaning process. Prices submitted from market-makers are scanned for outliers, validated and cleaned before they are normalized to provide a market consensus mean. Subsequently, Fitch CDS-IR performs its own set of cleaning rules to identify, correct, and potentially remove any further data errors.

After cleansing, spreads are smoothed using an exponentially weighted (time decaying) moving average in preparation for model estimation. This is done to obtain a smoothed non-linear representation of a time series, one that is more sensitive to long-term than to short-term fluctuations. This proves to be an effective countermeasure to “spread reversal”, a case where spreads of a higher rated company are worse than those of a lower rated company. The testing procedures implemented verify that the time decaying smoothing yields superior predictions and is capable of filtering out the ‘short-term noise.’<sup>4</sup>

<sup>4</sup> For further details on the testing results please refer to the Appendix.

Figure 3: Restructuring Prevalence across Regions



### The Fitch CDS-IR Model

The Fitch CDS-IR is designed to give the consensus marketplace view of obligor rating. The Fitch CDS-IR follows a two-step modeling approach: 1) smoothing, and 2) nonparametric mapping. The CDS market spreads in their raw state are noisy and individual spreads on any given day may be influenced by technical market factors. This volatility is especially evident in the pre-2003, Asian, or less liquid obligors, but it is an issue to be considered across the entire universe.

Fitch CDS-IR models only the most consistent and most abundant core of the CDS spread data available. Thus the focus is on only 5-year maturity of senior unsecured seniority that were quoted in the most populous restructuring type for each of the three global regions, see Table 1.

The objective is to predict obligor credit ratings. Since ratings are statements of credit quality that are ‘through the cycle’, typically assuming a time span on the order of approximately 5 (to 7) years from now, the market implied prediction must also be focused on this (relatively long) risk horizon. To address this, the Fitch CDS-IR model is organized into two stages: smoothing and mapping.

#### Smoothing

Spread series consist of long-term and short-term components. However, implied ratings are best predicted by utilizing the long-term components only. An alternative interpretation is that daily market spreads may contain short-term noise. New bond issuance, repositioning due to news announcements, and market technicals can all generate short term price changes that may not be a true indicators of fundamental

value. Under either viewpoint, techniques are available to isolate the long-term “signal” from the short-term “noise”. Having done this, the resulting signal will not only imply credit rating movements, but it will also be forward-looking because it is market-based.

There are a wide variety of techniques available to statistically smooth time series data. Starting with the simplest possible alternative and adhering to broadly recognizable procedures was a priority. Model investigation proceeded in steps by first establishing the base case of using raw (unsmoothed) spreads. This step highlighted “spread reversals” and its negative effects on even successfully being able to fit a model (e.g., rating grades may well cross unintuitively). In the model investigation steps that followed, every smoothing technique tested yielded significant improvement over this base case.

From robust statistics, the procedure of “trimming” commonly mitigates problems that can be introduced by data that is not Normally (Gaussian) distributed. When applied to CDS data, trimming improves performance not only on its own but also when used in conjunction with other methods. Hedrick-Prescott filtering and a simple Moving Average attain similar performance gains, where the Moving Average offers a far more parsimonious option.

Upon completion of testing, the Fitch CDS-IR model processes CDS spreads using both trimming and Exponentially Weighted Moving Average (EWMA). EWMA has the further inherent benefit that distant observations are “forgotten” in a gradual way. So the influence on model forecasts of a particular day’s observation is limited at the point when that day “drops out of” the moving window. The EWMA is calculated over a moving window of 365 days.

This smoothing technique is applied equally within all three regions of the world. As mentioned above, the only difference across the three regions with regard to data is the use of the most populous restructuring term within each region.

### Nonparametric Mapping

Why a mapping function? There are alternative ways to utilize CDS spread data to infer obligor credit quality. These include, for instance, complex reduced-form models to first infer obligor default probability (or perhaps total credit losses). The current Fitch CDS-IR model represents one of the most direct and assumption-free approaches: a simple mapping from market spread levels to credit rating.

Yet even with the simplicity of this model choice, there is a variety of approaches that might be taken. For example, both Ordered Probit and Ordered Logit guarantee that the *boundaries*<sup>5</sup> between rating grades are in strict rank order. Each approach however proved inflexible and exhibited relatively poor out-of-sample performance. Another approach followed Kou & Varotto (2004). They estimated boundaries with the objective function of minimizing the number of spreads that were misclassified. While intuitively appealing, this led to an objective function with undifferentiable gradients. In addition, applied to CDS data, K&V boundaries would commonly cross.

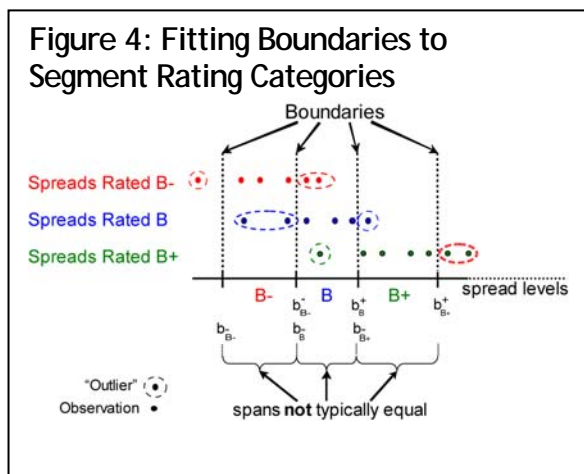
Fitch CDS-IR improves on this by specifying the sum of squared differences (between each spread and any crossed boundary). A further refinement is to “normalize” the objective function by dividing the squared differences by the number of spread

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<sup>5</sup> On a scale of CDS spread levels, dividing points (boundaries) are derived to best divide-up obligors of one rating grade from another.

observations within its rating. This enhancement insures that rating boundaries will not cross unintuitively. In fact, no artificial constraint against unintuitive crossing is needed.

The basic setup is to group daily smoothed spreads according to both agency rating and region. Then a mapping is fitted non-parametrically to optimal place boundaries separating rating groups. Importantly, these separating boundaries are identified uniquely for each region. A graphic illustration is as follows:



The above mapping process is performed daily and discretely on each of the three different geographic regions. This procedure insures an optimal separation/identification of rating categories, and (see Testing section below) generates powerful forecasts of credit ratings.

Formally, the objective (to be minimized) of the mapping function is as follows:

Equation 1:

$$\sum_r \sum_i^{n_r} \begin{cases} s_i > b_r^+ & \frac{(s_i - b_r^+)^2}{n_r} \\ s_i < b_r^- & \frac{(b_r^- - s_i)^2}{n_r} \\ else & 0 \end{cases}$$

where

- $i$  iterates over all spread observations
- $r$  iterates over all rating categories
- $s_i$  is the  $i^{\text{th}}$  spread, which will be in some  $r$  for all cases
- $b_r^+$  is the upper spread boundary for rating category  $r$
- $b_r^-$  is the lower spread boundary for rating category  $r$
- Note :  $b_r^+ = b_{(r+1)}^-$  The upper bound of a category is the lower bound for the next higher category
- $n_r$  number of spreads in rating category  $r$

Summed across all rating categories and across all CDS spreads within each category, the Fitch CDS-IR model first penalizes spreads that are above the rating boundary for its rating category (i.e.,  $s_i > b_r^+$ ). The penalty rises with the square of the distance making this function differentiable in all cases. A symmetrical penalty is assessed for spreads that are below the applicable rating boundary (i.e.,  $s_i < b_r^-$ ) and otherwise there is no penalty.

### Robustness Check and Model Performance Classification Matrix

In this section, the model validation and testing procedures are outlined. The most natural summary of implied rating is to see how many implied ratings exactly match the agency rating, and how many are within one notch, two notches, and so on. Fitch calls

this a Hit-Miss-Match (HMM) matrix. Table 2 and Table 3 report the HMM matrix for Americas and Oceania and Europe, respectively. Accordingly, one observes that for Americas and Oceania 30.9% of ratings match perfectly at the most granular level, and 71.7% and 89.0% are within one notch and two notches, respectively. For Europe the 33.0% match perfectly at the granular level, 78.6% are within one notch, and 88.4% are within two notches.

The goal of CDS-IR is to provide a timely and accurate representation of market information. Hence, it is important to note that one should not expect a 100% match of Fitch CDS-IR with agency ratings, but to anticipate that there should be a difference between these two. Clearly a thorough analysis of the mismatched cases would be of interest and would provide added insight. To focus on these mismatched cases (off-diagonal terms), a forward analysis is conducted.

**Table 2: HMM for Americas and Oceania**

		Implied Rating																Total		
		< CCC	B-	B	B+	BB-	BB	BB+	BBB-	BBB	BBB+	A-	A	A+	AA-	AA	AA+	AAA	Total	
A g e n c y  R a t i n g	< CCC	1.7%	0.5%	0.1%	0.1%														2.5%	
	B-	0.7%	0.7%	0.4%	0.4%	0.1%													2.4%	
	B	0.4%	1.1%	0.7%	0.7%	0.5%	0.3%												0.1%	3.7%
	B+	0.2%	0.9%	0.7%	1.0%	1.1%	0.7%	0.1%												4.7%
	BB-	0.1%	0.4%	0.6%	1.2%	1.0%	1.4%	0.4%	0.1%											5.2%
	BB		0.2%	0.4%	0.4%	1.0%	2.0%	1.4%	0.4%	0.1%										6.0%
	BB+		0.1%	0.1%	0.2%	1.2%	2.1%	1.1%	0.1%											5.0%
	BBB-				0.1%	0.1%	0.4%	2.0%	5.0%	2.2%	0.8%	0.1%								10.8%
	BBB					0.1%	0.2%	0.7%	2.5%	5.3%	5.0%	1.0%	0.4%							15.3%
	BBB+						0.1%	0.1%	1.2%	2.1%	3.8%	2.5%	1.0%	0.3%	0.1%					11.2%
	A-								0.3%	0.6%	1.4%	1.8%	2.3%	1.0%	0.4%	0.1%				8.1%
	A								0.1%	0.7%	1.0%	1.6%	2.4%	1.6%	1.2%	0.6%	0.1%	0.1%		9.3%
	A+								0.1%	0.2%	0.4%	0.6%	1.3%	1.4%	1.3%	1.0%	0.2%	0.3%	0.3%	6.6%
	AA-									0.1%	0.1%	0.3%	0.5%	0.5%	0.5%	1.2%	0.3%	0.7%		4.2%
	AA									0.1%	0.1%	0.1%	0.1%	0.2%	0.3%	0.3%	0.3%	0.7%		2.2%
	AA+													0.1%	0.1%	0.2%	0.1%	0.0%	0.2%	0.7%
	AAA															0.1%	0.2%	0.1%	1.2%	2.1%
Total		3.1%	4.0%	2.9%	4.0%	4.2%	6.4%	6.9%	10.7%	11.6%	12.7%	8.1%	8.3%	5.2%	4.2%	3.6%	1.0%	3.2%		

Diagonal Sum	±1 notches	±2 notches	Correlation
30.9%	71.7%	89.0%	90.5%

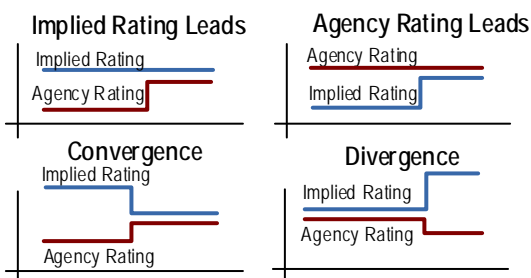
**Table 3: HMM for Europe**

		Implied Rating																Total	
		< CCC	B-	B	B+	BB-	BB	BB+	BBB-	BBB	BBB+	A-	A	A+	AA-	AA	AA+	AAA	Total
A g e n c y  R a t i n g	< CCC	0.1%	0.1%																0.3%
	B-	0.3%	0.4%	0.2%	0.1%	0.1%													1.2%
	B	0.2%	0.3%	0.4%	0.3%	0.1%													1.4%
	B+	0.1%	0.2%	0.3%	0.4%	0.3%	0.1%												1.5%
	BB-		0.1%	0.1%	0.2%	0.7%	0.3%	0.1%											1.7%
	BB					0.5%	0.8%	0.4%	0.2%										2.0%
	BB+	0.1%				0.1%	0.8%	1.1%	0.8%		0.1%								2.9%
	BBB-						0.4%	0.9%	2.4%	1.3%	0.5%	0.1%						0.1%	5.8%
	BBB							0.4%	3.6%	3.4%	3.5%	0.8%	0.1%						11.8%
	BBB+							0.1%	1.6%	2.0%	4.8%	2.4%	0.9%	0.1%	0.1%				12.1%
	A-								0.4%	0.9%	3.4%	5.8%	2.9%	0.8%	0.7%	0.2%	0.2%	0.2%	15.6%
	A								0.2%	0.1%	0.6%	3.4%	3.4%	1.7%	1.8%	0.2%	0.2%	0.1%	11.8%
	A+										0.1%	1.1%	3.4%	2.4%	4.4%	0.7%	0.2%	0.1%	12.5%
	AA-										0.2%	0.3%	1.2%	1.3%	2.2%	2.0%	1.5%	0.3%	9.1%
	AA											0.2%	0.3%	0.4%	0.9%	1.8%	1.7%	0.3%	5.6%
	AA+												0.1%			0.7%	1.4%	0.6%	2.8%
	AAA																0.6%	1.4%	2.1%
Total		0.9%	1.1%	1.1%	1.1%	1.9%	2.5%	3.0%	9.2%	7.9%	13.5%	14.0%	12.4%	6.8%	10.2%	5.7%	5.7%	3.1%	

Diagonal Sum	±1 notches	±2 notches	Correlation
33.0%	78.6%	93.8%	88.4%

Figure 5: Four Possible Relative Behaviors of Implied and Agency Ratings



## Forward Analysis

In an informationally efficient market, agency rating and CDS implied rating should mimic each other. Differences would suggest that either 1) ratings include additional issues such as volatility, or 2) they have different opinions about the future performance of individual firms. Tests follow to determine whether CDS-IR can anticipate a change in agency rating and vice-versa.

If the implied rating (IR) moves downward prior to an agency rating downgrade, IR “leads” the agency rating migration. Similarly, if IR moves up followed by agency rating upgrade, IR “leads” the agency rating migration. Contrarily, if IR upgrade (downgrade) is after agency rating upgrade (downgrade), agency rating leads implied rating. If their changes are in different directions, they either “diverge” (agency rating moves away from IR) or “converge” (both agency rating and IR move to each other).

Figure 6: Classification of Lead-Lag Analysis between Implied Rating and Agency Rating

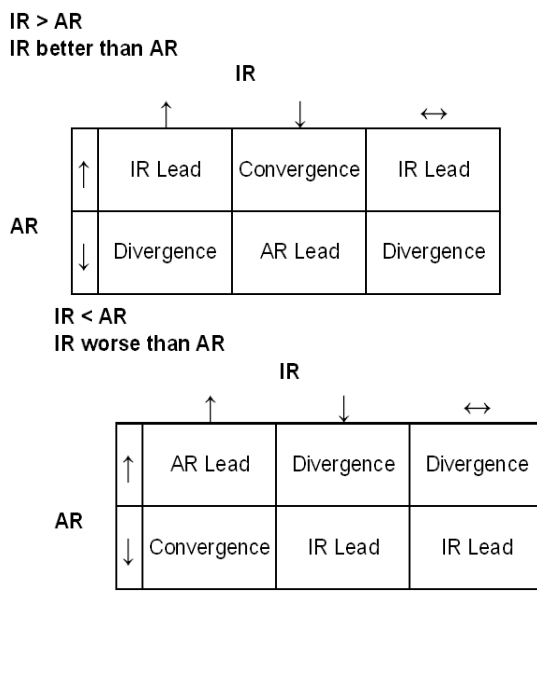


Table 4 and Table 5 report the lead-lag analysis for various time intervals prior to agency rating changes for Americas and Oceania and Europe. It is clear from the tables that agency rating adjustments are anticipated by CDS implied rating. For Europe at 3 months, about 47% of those off-diagonal terms the implied rating leads agency rating changes, and about 19% of agency rating changes lead the implied rating, which indicates that Fitch CDS-IR model can add information to a forecast of agency rating change for many cases.

The general trend is that CDS-IR leading behavior becomes increasingly more prominent while approaching the announcement date. This indicates that rating agencies respond to increasing number of warning signals and converging viewpoint on the quality of the credit in the marketplace. The clearer the signal, the more likely the rating will move in the direction indicated by the viewpoint that has already manifested in the market. More interestingly, as time goes by, the market appears to polarize around implied rating leading and divergence. Convergence, which occurs when the market and rating agencies appear to influence each other, subsides as we approach the announcement date. The implication is that, either ratings follow the market (IR lead), or they do not

**Table 4: Lead-Lag Analysis for CDS Implied Rating for Americas and Oceania (%)**

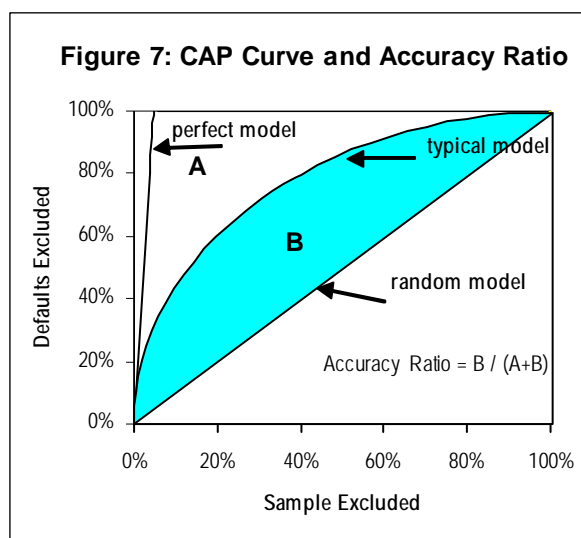
	IR Leads	AR Leads	Convergence	Divergence
1 Month	64.1	8.4	7.6	19.9
2 Months	58.0	12.2	12.5	17.4
3 Months	51.7	15.5	15.9	17.0

**Table 5 Lead-Lag Analysis for CDS Implied Rating for Europe (%)**

	IR Leads	AR Leads	Convergence	Divergence
1 Month	63.6	9.2	9.2	18.0
2 Months	55.9	12.5	14.1	17.4
3 Months	52.2	14.4	17.2	16.2

(diverge), but there is no indication that the market follows the ratings. In addition, the fact that the convergence declines as we get closer to the agency rating change suggests that agencies, although influenced by the market, are not over-sensitive to its signals and yield to market pressure only gradually.

Overall, the analysis shows that Fitch CDS-IR can predict the future movements of ratings. The leading effect is highly significant. The results for various intervals show that CDS-IR can provide early warnings before an AR change.



**Accuracy Ratio and Power Curves**

To test the credit ranking ability of CDS-IR, we use a standard statistic for measuring the ranking power of a model called the Accuracy Ratio (AR). The basic idea of this statistic is to measure the type I and type II errors using one ratio. To understand AR, one should first introduce Cumulative Accuracy Profile (CAP) curve. To obtain the CAP curve, all firms are sorted from worst to best by a model-generated ranking variable such as PD or, in our case, implied rating. For a given fraction x of total number of firms, the CAP curve is constructed by calculating the percentage of the defaulters whose

implied rating is within x percentile of implied ratings from the total sample. A perfect model would assign bad implied ratings for those defaulters, thus the CAP would increase linearly up to 100% and then stay at 100% as it travels to the right across the remainder of the population. In other words, all defaulters should fall into the worst implied rating bucket. For a random model without any discriminative power, the fraction of x% of firms will contain x% defaulters, which is the diagonal line in the Figure 7. The ratio between area of typical model with random model and perfect model is defined as the accuracy ratio (AR). Calculation of AR is explained in Figure 7. This statistics ranges from 0 to 1, the higher of AR, the better is a model in differentiating defaulters from non-defaulters<sup>6</sup>.

Table 6 shows the AR power based on CDS-IR. For comparison, Shumway statistics are also included as a benchmark. As the table illustrates, the AR for our model comes in at 84.6% in the one year horizon, beating both ratings and the Shumway model.

<sup>6</sup> More discussion of AR can be found in Engelmann, Hayden and Tasche (2003)

Figure 8 displays CDS-IR power curves for the same time horizons as in Table 6, where the steep slope of the graphs is indicative of the model rating power.

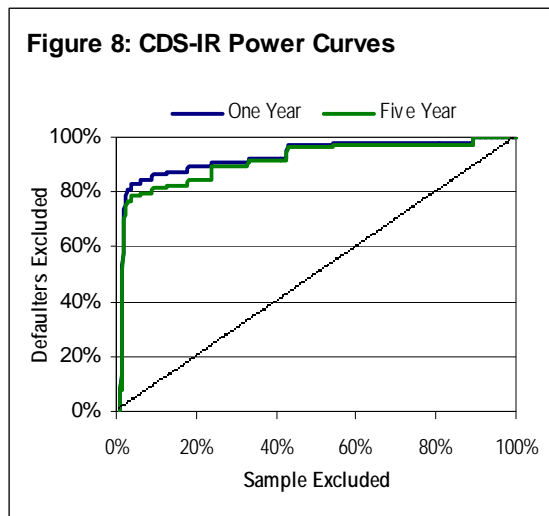


Table 6 Global ARs for 1- and 5-Year Horizons

(%)

AR	1 Year	5 Year*
CDS Rating	84.6	82.9
Agency Rating	82.2	80.8
Shumway	65.5	64.9

\*Five year results are somewhat misleading because the CDS data covers only a relatively short time span.

### Conclusion and Future Research

The Fitch CDS-IR model is a proprietary market-implied rating model. It is data intensive in its use of CDS spreads, sourced from Fitch CDS Pricing, globally to infer rating levels and anticipate rating changes. These spreads are smoothed using an Exponentially Weighted (time-decaying) Moving Average to yield a forward-looking view updated daily.

The marriage of Fitch’s CDS-IR model with Fitch’s extensive stream of CDS spreads - over 10,000 prices per day - has yielded forward-looking and insightful market-implied ratings.

Testing confirms that the Fitch CDS-IR model is consistently more effective, relative to alternative models, at predicting rating changes. It can be used as an early warning system for credit risk assessment and portfolio risk management.

Because no liability structure information for obligors is required, the Fitch CDS-IR is fully capable of addressing the financial, banking, and insurance industries, and covers the entire CDS universe globally.

Finally, there are alternative ways to utilize CDS spread data to infer obligor credit quality. The current Fitch CDS-IR model represents one of the most direct and assumption-free approaches. However, alternative methods offer the possibility of soliciting a default probability also and not just a credit rating. Fitch continues to actively pursue this research.

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## Appendix: Analysis of 5-day Moving Average Smoothing

Presented here is additional analysis to show the performance of an alternative technique which utilizes the minimum smoothing possible for model estimation. The 365 day EWMA smoothing analysis was discussed in the "Robustness Check and Model Performance" section. Below is a similar analysis of a simple 5 day Moving Average, which can be thought of as the "spot rate" in relative comparison.

### Classification Matrix: 5-day MA

Table 7 and Table 8 report the HMM matrix for Americas and Oceania and Europe, respectively. Accordingly, one observes that for Americas and Oceania 28.5% of ratings match perfectly at the most granular level, and 68.2% and 87.0% are within one notch and two notches, respectively. For Europe the 30.5% match perfectly at the granular level, 75.0% are within one notch, and 92.6% are within two notches. Note that all of

Table 7 HMM for Americas and Oceania (5-day MA)

		Implied Rating																		
		CCC<	B-	B	B+	BB-	BB	BB+	BBB-	BBB	BBB+	A-	A	A+	AA-	AA	AA+	AAA	Total	
A g e n c y  R a t i n g	CCC<	1.7%	0.4%	0.2%	0.1%														2.4%	
	B-	0.8%	0.6%	0.5%	0.3%	0.1%	0.1%												2.3%	
	B	0.5%	1.0%	0.6%	0.5%	0.6%	0.3%	0.1%											0.1%	3.6%
	B+	0.3%	0.9%	0.8%	0.7%	1.2%	0.6%	0.2%												4.7%
	BB-	0.1%	0.4%	0.9%	0.7%	1.1%	1.2%	0.4%	0.1%	0.1%										5.1%
	BB	0.1%	0.4%	0.4%	0.3%	1.0%	1.8%	1.3%	0.4%	0.1%	0.1%									5.9%
	BB+	0.1%	0.1%	0.1%	0.1%	0.4%	1.1%	1.8%	1.0%	0.3%	0.1%									5.0%
	BBB-			0.1%		0.1%	0.5%	2.2%	4.5%	2.1%	1.0%	0.2%								10.6%
	BBB					0.1%	0.2%	0.8%	3.0%	4.7%	0.9%	0.6%	0.1%						0.1%	15.1%
	BBB+						0.2%	1.3%	2.0%	3.5%	2.2%	1.1%	0.5%	0.1%					0.1%	11.0%
	A-						0.1%	0.3%	0.7%	1.4%	1.8%	1.9%	1.2%	0.5%	0.1%				0.1%	8.0%
	A						0.1%	0.2%	0.6%	1.1%	1.5%	2.0%	2.0%	1.2%	0.5%	0.1%			0.1%	9.3%
	A+							0.2%	0.4%	0.7%	1.2%	1.3%	1.4%	0.9%	0.2%	0.1%			0.3%	6.6%
	AA-							0.1%	0.1%	0.3%	0.4%	0.5%	0.7%	1.1%	0.3%	0.6%			0.6%	4.2%
	AA							0.1%	0.1%	0.1%	0.1%	0.2%	0.3%	0.5%	0.2%	0.6%			0.6%	2.1%
	AA+											0.1%	0.1%	0.1%	0.2%	0.1%	0.2%		0.2%	0.6%
	AAA												0.1%	0.1%	0.2%	0.3%	0.2%	0.1%	1.1%	2.1%
Total		3.5%	3.7%	3.5%	2.7%	4.7%	5.7%	7.2%	11.0%	10.9%	12.4%	7.7%	7.4%	6.0%	4.7%	3.5%	1.0%	3.1%		

Diagonal Sum	±1 notches	±2 notches	Correlation
28.5%	68.2%	87.0%	89.1%

Table 8 HMM for Europe (5-day MA)

		Implied Rating																		
		CCC/C	B-	B	B+	BB-	BB	BB+	BBB-	BBB	BBB+	A-	A	A+	AA-	AA	AA+	AAA	Total	
A g e n c y  R a t i n g	CCC/C	0.1%	0.1%																0.2%	
	B-	0.3%	0.4%	0.2%	0.1%	0.1%													1.2%	
	B	0.2%	0.3%	0.4%	0.3%	0.2%													1.3%	
	B+	0.1%	0.2%	0.3%	0.4%	0.3%	0.1%												1.4%	
	BB-		0.1%	0.1%	0.3%	0.6%	0.4%	0.2%											1.6%	
	BB				0.1%	0.5%	0.6%	0.5%	0.2%										2.0%	
	BB+	0.1%				0.2%	0.8%	0.9%	0.7%		0.1%								2.8%	
	BBB-					0.1%	0.3%	0.9%	2.5%	0.9%	0.8%	0.1%							0.1%	5.7%
	BBB					0.1%		0.5%	3.8%	2.6%	3.3%	1.1%	0.3%							11.7%
	BBB+						0.1%	0.1%	1.9%	2.2%	4.0%	2.3%	1.2%	0.1%	0.1%					12.0%
	A-							0.7%	1.1%	3.3%	5.4%	2.9%	0.9%	0.5%	0.3%	0.2%	0.2%		15.5%	
	A							0.3%	0.2%	0.8%	2.8%	3.6%	2.0%	1.5%	0.4%	0.1%	0.1%		11.8%	
	A+								0.1%	0.2%	1.1%	3.5%	2.7%	3.6%	0.9%	0.2%	0.2%		12.5%	
	AA-									0.2%	0.1%	0.2%	1.2%	2.2%	2.1%	1.6%	0.4%		9.0%	
	AA										0.2%	0.1%	0.4%	1.1%	1.6%	1.6%	0.4%		5.6%	
	AA+											0.1%	0.2%	0.9%	1.1%	1.1%	0.6%		2.8%	
	AAA														0.1%	0.6%	1.4%		2.0%	
Total		0.8%	1.0%	1.0%	1.2%	2.1%	2.3%	3.2%	10.1%	6.9%	12.6%	13.3%	13.0%	7.4%	9.3%	6.1%	5.4%	3.3%		

Diagonal Sum	±1 notches	±2 notches	Correlation
30.5%	75.0%	92.6%	88.9%

the notching difference results of the MA(5) are inferior to the final CDS-IR model.

**Forward Analysis: 5-day MA**

Table 9 and Table 10 report the Lead-Lag Analysis for Americas and Oceania and Europe, respectively. For Europe at 3 months, about 47% of those off-diagonal terms the implied rating leads agency rating changes, and about 19% of agency rating changes lead the implied rating, which indicates that Fitch CDS-IR model can add information to a forecast of agency rating change for many cases.

**Table 9: Lead-Lag Analysis for CDS Implied Rating for Americas and Oceania (5-day MA)**

(%)

	IR Leads	AR Leads	Convergence	Divergence
1 Month	54.5	11.9	18.2	15.4
2 Months	46.3	15.6	24.8	13.3
3 Months	41.2	19.7	25.8	13.3

**Table 10: Lead-Lag Analysis for CDS Implied Rating for Europe (5-day MA)**

(%)

	IR Leads	AR Leads	Convergence	Divergence
1 Month	53.4	12.8	19.9	13.9
2 Months	47.6	17.0	23.5	11.9
3 Months	47.2	19.3	22.8	10.8

The performance of the 5-day Moving Average is also inferior vis-à-vis as the 365-day EWMA model, but it is not very poor. Separately, the “signal” of a 5-day MA is more volatile relative to the 365-day EWMA smoothing used in the final CDS-IR model. Thus the use of the longer range represented by a 365-day term is warranted.

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